

**OPAG-WWRP**

**Report on Recent WWRP Major Field Campaigns and Demonstration Projects**

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**Purpose of Document and Major Decision(s) Requested**

The purpose of this document is to provide a progress report highlighting the recent major field and/or modelling campaigns of the WWRP including:

- i. T-PARC/TCS-08,
- ii. Beijing 08 RDP and FDP,
- iii. European Coordinated Experiment
- iv. Future plans for major campaigns of WWRP.

The Management Group is requested to:

- i. Provide feedback on these activities including analysis phase and future plans.
- ii. Ensure that these campaigns are a major element of the Technical Conference planned for Seoul in November 2009, especially for topics of interest to the host nation, Korea, and the other nations of Asia.

**Summary of Activity**

**1. INTRODUCTION**

The activities of World Weather Research Programme (WWRP) activities include major field campaigns and focused modelling efforts with a fixed time frame. This report briefly highlights these activities.

**2. T-PARC AND TCS-08**

The THORPEX Pacific Asian Regional Campaign (T-PARC) and the Tropical Cyclone Structure (TCS-08) Experiment projects were organized to address three distinct phenomena: i) Tropical cyclones; ii) The extratropical transition of tropical cyclones; and iii) Winter storms. These experiments were motivated by the need to improve the regional prediction of these phenomena over eastern Asian and the western Pacific as well as the medium range prediction problem associated with role of these phenomena in the downstream generation of high impact weather. The experimental objectives range from testing strategies to improve prediction in an operational setting to increasing our

understanding of these phenomena and the factors that currently limit forecast skill. Given this span of objectives, T-PARC and TCS-08 includes participation from operational centres, the academic research community and from research institutes. While it is tempting to think of T-PARC and TCS-08 as a field campaign, the project also has an extensive modelling component with an analysis phase that will continue for many years. The nations that participate (or will participate) in T-PARC and TCS-08 through providing observations, operational modelling and/or sounding support, and analysis, include Australia, Canada, China, France, Germany, Indonesia, Japan, Korea, Mexico, Philippines, Russia, UK, US, and Viet Nam. TCS-08 and T-PARC also have important collaborations with the measurement and modelling activities of the operational DOTSTAR targeting effort for tropical cyclone studies. A collaboration with the PREVIEW project led to their involvement in all phases of T-PARC/TCS-08 through the utilization of the ECMWF web-based tools for calculating sensitive areas for all phases of T-PARC. TIGGE data is, of course, of interest to T-PARC/TCS-08 investigators with the

## 2.1 Tropical Cyclone and Extratropical Transition (ET) Phases

The field phase of the THORPEX Pacific Asian Regional Campaign (T-PARC) and the Tropical Cyclone Structure (TCS-08) Experiment that focused on investigations tropical cyclones took place from 1 August to 6 October 2008. The North American and Asian Regional Committees of THORPEX were responsible for initiation T-PARC, while the TCS-08 was organized by the WWRP Working Group on Tropical Meteorological Research (WGTMR) relatively late in the planning process for T-PARC. In reality, there was a close connection between these two efforts from the early stages of the T-PARC planning as the scientific plans for T-PARC were strongly influenced by previous efforts by the WGTMR to identify research priorities and forecast needs.

The topics of interest to TCS-08 and T-PARC for this phase include:

- Assessing the impact of Doppler lidar, water vapor lidar and targeted in-situ measurements on predictions of the genesis, structure, intensity, track, ET and downstream impact of tropical cyclones. For track forecasts, forecasts by deterministic and ensemble models during cyclone recurvature were of particular interest.
- The factors that limit the prediction of tropical cyclone genesis, intensity and structure. One focal point under this topic is how the interaction between deep convection and the large-scale flow control the genesis, intensity and structure (e.g., size) of tropical cyclones.
- Assessing and improving the accuracy of satellite-based estimates of tropical cyclone intensity (e.g., Dvorak-type techniques) by field campaign measurements, which has implications for cyclone forecasts and the climatic record of such events.
- Advancing knowledge of the ET process and the effect of ET on the downstream generation of high impact event.

The field measurements taken included:

- Dropsondes and airborne flight level meteorological data, Doppler wind lidar, and water vapor lidar with quantitative aerosol measurements were taken on the DLR Falcon.
- Dropsondes and airborne flight level meteorological data, radiometer and scanning Doppler radar measurements taken on the NRL P-3.
- Dropsondes and airborne flight level data on the AF C-130.
- Dropsondes from stratospheric balloons using the driftsonde system.
- Supplemental radiosonde launches from land-based sites and Japanese research vessel.

The conditions were very suppressed during August 2008 with anomalous low-level easterlies and only one named cyclones. September was more active allowing all the scientific objectives to be measured. While the field phase was just concluded, the initial impressions from the field investigators (based on discussions with Pat Harr and Wen-chau Lee) are:

- An unprecedented data set was accumulated for investigations into the impact of Doppler lidar wind information on predictions of tropical cyclones and cyclone-related phenomena. While promising forecast improvements were noted for a limited number of middle latitude systems in A-TREC, both the volume of Doppler lidar data and its application for tropical cyclone systems are unique.
- Multiple aircraft (up to 4) were used to deploy dropsondes in targeting in sensitive regions of tropical cyclones for the first time in the Pacific. While past investigations have shown targeting to be relatively successful (more so than for winter cyclones), impact studies from this data set will provide great insight into how targeting should be accomplished for tropical cyclones in the future.
- Four named cyclones were sampled as well as several systems that did not develop into name cyclones. One system was sampled over its entire lifecycle (from near genesis to ET).
- The genesis regions of tropical cyclones were sampled for the first time using airborne Doppler radar measurements accompanied by dropsondes. Future investigations will provide insight into the false alarm rate for the prediction of tropical cyclones.
- The first measurements were made of a category 5 tropical cyclones including an extensive set of surface/oceanographic buoys deployed ahead of the storm.
- The airborne Doppler radar produced an extremely unique data set for investigations into the structure of deep convection associated with typhoons. In particular, the outer rainbands contained severe convection and an unexpected evolution,

## 2.2 Winter T-PARC

The field phase for the Winter Phase of T-PARC (Winter T-PARC) will take place during a six-week period during January-March 2009. One focus on T-PARC and the experimental design will build on the operational targeting efforts of NOAA's Winter Storms Reconnaissance Program over the Pacific. During Winter T-PARC, sensitive regions will be calculated by ECMW, NOAA, Meteo France, (UK) Met Office, and NRL. Observations taken during the winter phase of T-PARC include dropsondes from the NOAA G-4 aircraft, dropsondes with the AF C-130, and supplemental radiosonde launches, primarily from the Russian radiosonde network. The measurement strategy will allow sensitive areas to be repeatedly sampled as these areas move from Asia and across the Pacific.

The research topics of interest to winter T-PARC include:

- Targeting
  - Will repeated sampling in time improve the impact of targeting?
  - How do linear assumptions limit current targeting methods for adjoint and ensemble-based methods?
  - Can the lead time limit for targeting be extended for the medium range?
  - What is the potential for adaptive use of satellite data?
- Dynamics
  - What processes initiate and intensify Rossby waves?
  - How predictable are explosive Pacific cyclones and what is dynamics of these storms?

- Are forecast failures in the medium range over North America associated with errors in initial conditions over the northwest Pacific?
- Are supplemental measurements justifiable from the viewpoint of users of weather prediction (e.g. winter Olympics, water resources).

### **3. BEIJING 08 OLYMPIC FORECAST DEMONSTRATION AND RESEARCH AND DEVELOPMENT PROJECTS (BEIJING 08 FDP AND RDP)**

#### **3.1 Beijing 08 FDP**

A WWRP Forecast Demonstration Project (FDP) focused on nowcasting was conducted during the Beijing 08 Olympics. Nowcasting systems rely on combining radar and other observations with model output to provide forecasts for very short-term (0 to ~6h). The WWRP focus on nowcasting for the past several years has been on prediction of convective weather. Although the focus was on the period during and near the Olympic and Paralympic games, the preparations and test phase span over years. Since Nowcasting systems are typically run locally, the FDP and associated testing phase allows an intercomparison between multiple research and operational systems. In the past such FDPs have isolated shortcomings in the various systems and subsequent improvements to various nowcasting systems.

The goals of the Beijing 08 FDP include:

- To implement advanced high impact weather nowcast systems in Beijing for meteorological services supporting the B08 Olympics;
- To demonstrate the usefulness of nowcast techniques to B08 Olympics meteorological services;
- To share the new technology on operational nowcasting systems and verification techniques with the intent of improving future systems;
- To assess the impact of the implementation of operational nowcast systems of B08FDP on local forecasters and end-users;
- To promote the development and application of nowcasting techniques in China and other WMO members.

The nowcasting systems that participated in the B08 FDP were:

- BJ-ANC (China and US)
- CARDS (Canada)
- GRAPES-SWIFT (China)
- MAPLE (Canada)
- NIWOT (US)
- STEPS (Australia)
- SWIRLS (Hong Kong, China)
- TIFS (Australia)

The project was viewed as a success and a write-up on the effort is being assembled for an article in the WMO Bulletin and subsequent journals. Given the progress from the Beijing 08 FDP and other past WWRP efforts to nowcast warm season convection (e.g., MAP-D Phase, Sydney 2000), the next effort will likely be associated with winter weather. Further details on the Beijing 08 FDP can be found at [www.b08fdp.org](http://www.b08fdp.org).

### 3.2 Beijing 08 RDP

The Beijing 08 project focused on the development and application of mesoscale ensemble prediction systems. The RDP by definition had a greater emphasis on research aspects than the nowcasting FDP effort. The objectives of the Beijing 08 RDP include:

To **improve understanding** of the high-resolution and very short range probabilistic prediction processes through numerical experimentations and diagnoses;

To **share experiences** on the development of the real-time Mesoscale Ensemble Prediction (MEP) systems;

To **demonstrate** how MEP system can improve high impact weather forecasts;

To **develop adequate methods** on the assessment of the capability and forecast skill of MEP systems;

To **train forecasters** to use ensemble forecasting products & support better meteorological services for 2008 Olympic Game;

To **setup shareable database/archived data sets** for future research in the community.

The modelling effort was organized into two tiers. The first tier contained regional models with resolution of order 15 to 25 km. The model systems involved including NCEP, MSC, JMA, (UK) Met Office, CMA and M-F/ZAMG. The simulations for this model tier were performed on the home computing facilities of the participating nations. The second tier of modelling had a high-resolution (2-4 km) horizontal grid spacing over 1320 by 1100 km horizontal grids. These simulations were conducted on the CMA computing facilities. The description of the Beijing 08 RDP will also be presented in the same WMO Bulletin article mentioned earlier.

## 4. EUROPEAN COORDINATED EXPERIMENTS

A coordinated experimental effort associated with the WWRP took place in Europe during 2007. The effort included: i) the European THORPEX Regional Campaign (1 July to 1 Aug 2007) that was associated with first targeted in-situ measurements for continental warm season convection, ii) the EUMETSAT special observational data period (1 June to 31 August 2007) which is discussed in Aoshima et al. (accepted) MetZet 2008, iii) the Convective and Orographically-Induced Precipitation Study (COPS) (1 June to 31 August 2007), which is a WWRP RDP and is discussed (Wulfmeyer et al. BAMS 2008), iv) The Mesoscale Alpine Programme's Demonstration of Probabilistic Hydrological and Atmospheric Simulation of Flood Events in the Alpine region (MAP D-PHASE), was a WWRP Forecast and Demonstration Project (FDP) that took place from 1 June to 30 November 2007. The MAP D-PHASE effort is described in detail in Rotach et al. submitted BAMS (2008).

The field phase of the MAP D-Phase was the only component of the European Coordinated Experiments that took place after last year's meeting of the CAS Management Committee. Hence, we will only present a brief report of the MAP D-Phase herein. Table 4.3.1 below taken from a summary presentation by MAP D-Phase investigators shows the large scope of the MAP D-PHASE effort.

**Table 4.3.1 Summary Numbers for MAP D-PHASE**

Affiliated countries	17
Affiliated institutions	120
Known users of www.d-phase.info	357
Modelers and forecasters	175
End-users among them	166
Number of deterministic NWP	23
Number of high resolution deterministic NWP (grid size < 5x5 km <sup>2</sup> )	11
Number of ensemble NWP	7
Number of hydrological models	7
Number of nowcasting platforms	4
Number of meteorological target areas	74
Number of hydrological impact areas	60
Data stored in the data archive by November 30 <sup>th</sup> 2007	~13 TB
Questionnaires sampled for end-user feedback analysis	50

The general philosophy of the MAP D-PHASE was end-to-end with an adaptive modelling strategy. In this strategy, global and limited area ensemble modelling systems were used to determine if an alert should be issued for a flooding situation with a 3 to 5 day lead-time. If the limited area ensembles were predicting a flood at 1 to 2-days before the event, high-resolution atmospheric models were utilized with typically resolutions of approximately 2 to 4 km. If the combined results of these high resolution models predicted an event than the hydrological models were utilized. At day 1, nowcasting and observations were added to the predictive systems. The entire range of products for users were displayed through a single visualization system. MAP D-PHASE included verification efforts and allowed for user feedback. The strength of MAP D-PHASE is the strong link with hydrological prediction and the SERA component with a large number and variety of users.

## 5. FUTURE PLANS

The community has been discussing the following efforts as possible WWRP and WWRP-THORPEX projects. In compiling this list, we were inclusive as it is typical that more efforts develop from the planning process than are funded by national agencies.

- **HEPEX (Hydrological Ensemble Prediction Experiment)** has sent representatives to several THORPEX planning meetings. John Schaake of NOAA, the lead of HEPEX has proposed closer links be developed between THORPEX and HEPEX. The motivation is that hydrology is a critical user of weather information and the goals of TIGGE and HEPEX are complementary.
- **Regional Centers will be developed for Sand and Dust Storm (SDS-WAS) in 2009. We anticipate that these centers will provide for basic research into how to improve the incorporation of dust aerosol into numerical models as well as early operational prediction and user application projects (e.g., health and transportation are prime sectors).**
- **Shanghai MHEWS (Multi-hazard Early Warning System)** is proposed to take place in 2010 with the involvement of the WWRP being limited to the development of a verification system for tropical cyclone prediction and mesoscale ensemble research.
- **TIGGE SERA demonstration projects.** The TIGGE archive represents an unprecedented research tool to address a number of THORPEX research

topics. The opportunity exists for several SERA-type projects that utilize products derived from TIGGE data. Since real-time tropical cyclone tracks have been produced for TIGGE, we anticipate that operational use of this data set and regional centres is an excellent first choice for such a project. Other efforts could be in the areas of flooding, health or food security.

- **A Nowcasting FDP is being planned for the Vancouver 2010 Winter Olympics.** This winter effort represents a new direction in the activities of the nowcasting working group as previous efforts have focused on warm season convection. The winter environment in the vicinity of Vancouver represents a very challenging environment for transportation for spectators and for the operation of the events. The effort may be expanded to include mesoscale modeling.
- **T-NAWDEX (THORPEX North Atlantic Waveguide and Downstream Impacts Experiment)** is being planned under the leadership of the European THORPEX Regional Committee for 2011 or 2012. The experiment seeks to address: i) the triggering of waveguide disturbances by different processes and the disturbances' subsequent downstream evolution and study of the downstream impacts of the waveguide disturbances over Europe, the Mediterranean, and northern Africa. A center-piece of the measurement strategy will be the new German high performance, high altitude jet called HALO.
- **HYMEX (Hydrological Cycle in the Mediterranean Experiment)** is being planned under the leadership of the French scientific community who propose a major multi-disciplinary and multi-scale experimental project with enhanced and special observational periods. HYMEX will address issues related to the Mediterranean coupled system controlling the regional water cycle and plans to monitoring relevant atmospheric, oceanic, hydrological and bio-chemical variables during a long observation period with additional and dedicated ground-based, shipborne and airborne means in 2011-2012. HEMEX will include hydrological and atmospheric prediction systems and WWRP-THORPEX is investigating whether to develop close collaborations with HYMEX as it develops into a major international effort.
- **Mesoscale Modeling Testbeds:** The Mesoscale Forecasting Research Working Group has proposed that reference cases or testbeds be focal points for attacking their priorities.
- **Tropical cyclone field campaigns in the 2011-2013 time-frame:** Two possible efforts that would build on T-PARC/TCS-08 have been discussed in very early planning stages. One possible experiment is a campaign in the Bay of Bengal led by India and another is in the western Indian Ocean with the Regional Specialized Forecast Center in La Reunion.